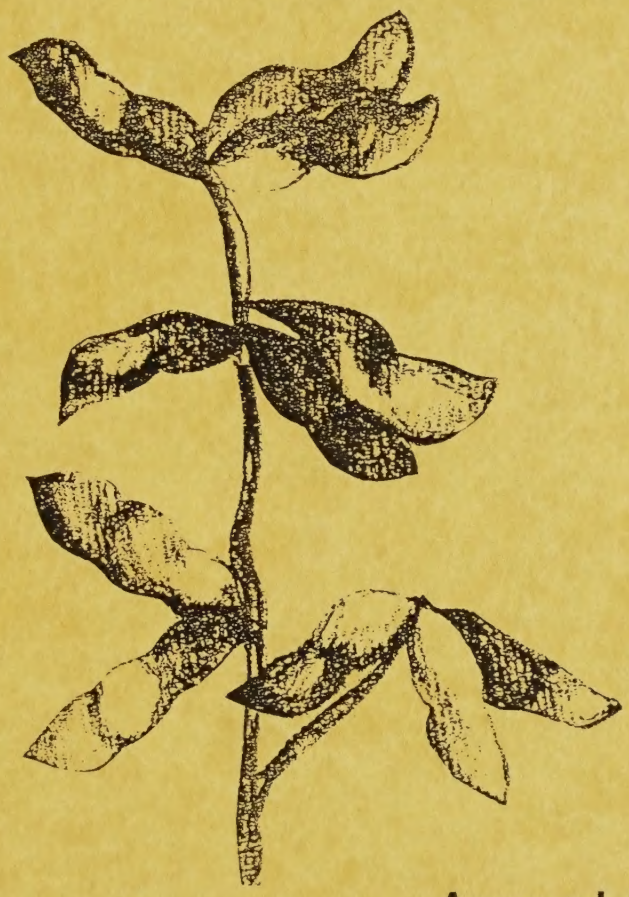
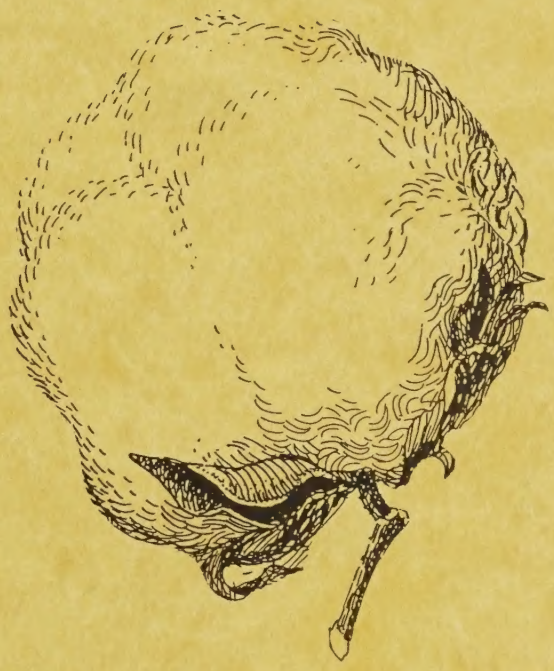
SOUTHERN INSECT MANAGEMENT LABORATORY USDA/ARS

Stoneville, Mississippi





Annual Report on
Progress (CY 1991) and
Plans (CY 1992)

CONTENTS

I. Introduction

This report summarizes progress made on various research objectives in 1991 and presents plans for 1992.

Many of the results are preliminary and others are being released through established channels. Therefore, this report is not intended for publication and should not be referred to in literature citations.

The intent of this report is to give the reader an overview of Southern Insect Management Laboratory (SIML) research activities. These activities (progress and plans) address the laboratory and unit missions (listed on pages 4-7). To accomplish the mission, the Laboratory is divided into one unit at Stoneville (Southern Insect Management Research Unit (SIMRU)) and one unit at Mississippi State (Insect Rearing Research Unit (IRRU)) which is housed in the R. T. Gast Rearing Laboratory.

SIML activities are centered around seven research thrusts, which reflect present CRIS work units. These are:

(1) Biological and genetic control of crop insect pests, emphasizing Heliothis/Helicoverpa;

(2) Population ecology of insect pests for integrated control/ management systems;

(3) Biology, ecology, and behavior of plant bugs and cotton aphids;

(4) Strategies for managing crop insects, emphasizing the cotton agroecosystem and pesticide effectiveness;

(5) Integrated control of pecan pests;

(6) Host plant resistance in soybean pests; and

(7) Mass propagation technology for the boll weevil, Heliothis/Helicoverpa, and Microplitis croceipes (Cresson).

The first through sixth areas are researched by the SIMR Unit and the seventh by the IRR Unit.

This report is divided into four sections:

(1) Report on research progress in CY 1991;

(2) List of publications including those in press and accepted for publication;

(3) Other indicators of progress such as presentations and papers in manuscript; and

(4) Plans for CY 1992.

In each section, items are arranged by researcher (in alphabetical order of lead scientist; the name of lead scientist and cooperating and/or collaborating researchers are provided for each item). If the reader has questions pertaining to the item, he/she should contact the individual scientist, research leader, or laboratory director.

II. Mission Statement and Staff

SOUTHERN INSECT MANAGEMENT LABORATORY
ARS/USDA, Mid South Area
Stoneville, Mississippi 38776
Telephone: Comm. 601-686-5231
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OFFICE OF LABORATORY DIRECTOR

Mission:

The mission of the Southern Insect Management Laboratory is to conduct fundamental research on the biology, ecology, and rearing of field crop and pecan insect pests and their natural enemies; develop innovative biological, genetic, cultural, and chemical methods for suppressing insect pests; and integrate this knowledge into insect management systems. A goal of this laboratory is to develop new and improved insect pest suppression strategies, including improvements in pesticide effectiveness, for population management approaches to improve crop production efficiency. Exotic organisms are received and cleared through the Stoneville Research Quarantine Facility for biological control of insects and weeds. Exotic predators and parasites are released and evaluated for establishment on field crop insect pests.

ARS PERSONNEL:

D. D. Hardee, Laboratory Director
T. G. Burton, Secretary
L. E. Taylor, Office Automation Assistant
W. W. Harrison, Quarantine Officer
G. G. Hartley, Entomologist (Insect Rearing)
H. E. Winters, Biological Technician (Insect Rearing)
J. D. Warren, Instrument Maker (Shop)

SOUTHERN INSECT MANAGEMENT RESEARCH UNIT

Mission:

To develop new knowledge on the biology of field crop insects for development of new and improved control principles and to establish fundamental principles for encouraging and using natural enemies more effectively. To develop and integrate insect suppression strategies into field crop and pecan systems that minimize the cost of plant protection, yet are ecologically acceptable. Specifically:

1. Elucidate the efficacy of indigenous predators and parasites, particularly those attacking the bollworm, Helicoverpa zea, and tobacco budworm, Heliothis virescens.

2. Research and develop methods for augmenting parasite populations to manage insect pests of field crops, particularly use of Microplitis croceipes for control of Heliothis/Helicoverpa.

3. Develop new knowledge on biology and behavior of Heliothis/Helicoverpa spp., initially emphasizing genetic characterization of Helicoverpa for establishment of a bollworm sterile hybrid.

4. Conduct basic biological and ecological research on plant bugs, particularly the tarnished plant bug, Lygus lineolaris, and aphids, particularly the cotton aphid, Aphis gossypii.

5. Develop monitoring and predictive technology through quantitative population ecology for field crop insect pests, particularly bollworm/budworm and tarnished plant bug.

6. Assess the role of early season host plants in the buildup of Heliothis/Helicoverpa and tarnished plant bug populations and devise new and innovative tactics for suppressing these populations.

7. Develop chemical/biorational control tactics for use in integrated systems.

8. Develop chemical, biological, and other nonchemical methods for control of insect and mite pests of pecans. Evaluate selections and native pecans for yield and adaptability to the mid-south.

9. Locate, develop, and evaluate soybean cultivars resistant to insects.

ARS PERSONNEL:

D. D. Hardee, Research Leader, Laboratory Director
(Supervisory Research Entomologist)

M. R. Bell, Research Entomologist
A. M. Nandihalli, Biological Technician

G. W. Elzen, Research Entomologist
L. C. Adams, Biological Technician

D. E. Hendricks, Research Entomologist
D. W. Hubbard, Biological Technician

L. Lambert, Research Entomologist
W. L. Solomon, Biological Technician, Student Trainee

M. L. Laster, Research Entomologist
S. B. Ginn, Biological Technician

W. P. Scott, Research Entomologist
D. A. Adams, Biological Technician

M. T. Smith, Research Entomologist
R. W. Hoagland, Biological Technician

G. L. Snodgrass, Research Entomologist
R. A. Drake, Biological Technician

Vacancy, Research Entomologist
F. M. Williams, Biological Technician

A. A. Weathersbee, Research Entomologist (Research Associate)

INSECT REARING RESEARCH UNIT

Mission:

The goal of this management unit, located at Mississippi State, Mississippi, is to develop science and technology of mass propagation, storage, transfer, and release of cotton insects emphasizing the boll weevil, Heliothis, Helicoverpa, and the parasitoid, Microplitis croceipes (Cresson). Specifically:

1. Research is directed toward establishment of a cost effective propagation program capable of producing the quantity and quality of insects required to support field evaluation needs.

2. Initial research emphasis is placed on boll weevil production, automation of Heliothis/Helicoverpa and Microplitis rearing, establishment of quality control standards, establishment of standards for shipping and releasing insects, and evaluation of new rearing methods.

ARS PERSONNEL:

D. D. Hardee, Research Leader/Laboratory Director
(Supervisory Research Entomologist)

J. L. Roberson, Supervisory Entomologist
T. L. Blair, Insect Production Worker
E. M. Griffin, Biological Technician
D. K. Harsh, Engineering Technician
O. L. Malone, Biological Laboratory Technician
G. G. McCain, Secretary
C. Tate, Insect Production Worker
M. Tate, Insect Production Worker

III. Summary of Research Progress for Calendar Year 1991

A. Narrative

1. In-House

The second year of a large area pilot test involving treating all early season hosts of the budworm/bollworm complex within a 100 square mile area with an entomopathogenic virus was conducted. The experiment involved coordinating several activities (i.e. public information, aerial application, evaluation of effectiveness through cage and pheromone trap data). Although 80% of the test area became flooded during the treatment period, useful insect trap data were collected which indicated the flooding affected budworm/bollworm emergence from the first seasonal larval generation by reducing the populations as much as 50% or more. The laboratory production of the virus needed for the pilot test demonstrated the feasibility of using entomopathogenic viruses for large-scale pilot tests, producing enough virus to treat 12,800 acres using a small facility. The ease of in vivo production and methodology was of interest to other scientists as well as industry, including foreign interests. (M. R. Bell)

The methodology for virus production was then used to produce virus for a cooperative study to evaluate a new candidate viral insecticide at this location, as well as at ARS facilities at Phoenix, AZ and Fresno, CA. (M. R. Bell)

A small-plot field trial of a new baculovirus of industrial interest was conducted on small plots to compare its effectiveness in controlling budworms/bollworms in cotton to two other baculoviruses. Although populations were low, results indicated that the new virus was effective in reducing populations but no more so than the viruses already marketed. (M. R. Bell)

On-going laboratory bioassays of various viruses as well as new strains of the microbial insecticide, Bacillus thuringiensis, did not indicate any isolates of increased potency to cotton insects. (M. R. Bell)

During 1991, eight tobacco budworm strains collected from velvetleaf and cotton were evaluated for resistance to four classes of insecticides to determine the spectrum of resistance, to compare resistance levels to levels obtained in previous years, and to determine if multiple resistance was present as it was in 1990. A spray table bioassay confirmed that resistance to pyrethroid, carbamate, and organophosphate insecticides remains in Mississippi populations, and that increased tolerance to endosulfan (an organochlorine) was present in three of the strains tested. The initial tolerance to endosulfan observed in the Stoneville laboratory insecticide-susceptible strain is probably related to a history of resistance to toxaphene. Likewise, predisposition to resistance toward endosulfan probably caused the reduced mortalities seen in the three field strains, but the increased tolerance (over that found with the susceptible strain) may be an expression of the recent increased use of endosulfan during the early season for control of other secondary pests. (G. W. Elzen)

In contrast to cases in the literature, several pyrethroid-resistant tobacco budworm strains collected from cotton in 1990 did not lose resistance (revert) between the F_1 and F_2 generations (without insecticide pressure) in culture in the laboratory, as determined by two different bioassays (spray table and topicals). Furthermore, a strain which was resistant to pyrethroids, carbamates, and organophosphates (when collected) did not revert to complete susceptibility to these classes of insecticides until the F_{12} generation in the laboratory. Slight reversion was detected by the F_8 generation. The stability of resistance probably indicates that target site and metabolic mechanisms of resistance to pyrethroids are now present in field populations of tobacco budworm. Previous concensus noted only target site resistance to pyrethroids. Likewise, it appears that resistance to thiodicarb (a carbamate) is also multifactorial. The temporal sequence of resistance under field conditions also appears to be somewhat stable as evidenced by adult vial test data and other data obtained in two separate areas/populations over two years. (G. W. Elzen, S. Martin, J. B. Graves)

Two separate bioassays were replicated twice to determine the inheritance of pyrethroid and carbamate resistance in tobacco budworm derived from reciprocal crosses of a field strain with multiple resistance and an insecticide-susceptible laboratory strain. Preliminary analyses of the data indicate that resistance is not inherited as a recessive trait. These findings may aid in explaining the stability of resistance found in other tests. Further study is planned. (G. W. Elzen, J. B. Graves)

Ovicidal activity of fourteen treatments on tobacco budworm eggs was evaluated in replicated small plot trials. Curacron was the most effective ovicide tested in agreement with results from previous studies in 1989 and 1990. (G. W. Elzen)

Fourteen treatments were tested for aphicidal activity in replicated small plot trials. MetaSystox-R and Lorsban-Capture mixtures were the more effective treatments. Other Lorsban-pyrethroid mixtures were not as effective. (G. W. Elzen)

Various insecticides and B.t.'s were tested in spray table bioassays on tobacco budworm, bollworm, and beet armyworm larvae. Results were reported directly to chemical companies through research agreements. (G. W. Elzen)

Second-year studies of the effect of in-furrow insecticides at planting on seasonal development of aphicide resistance in the cotton aphid confirmed 1990 studies in showing that all treatments produced aphids that were more resistant than a resistant colony maintained for two years in the laboratory. Even with these results, however, this cotton production practice, which is one of the currently recommended steps in cotton aphid resistance management, should be continued until additional solutions can be found. (D. D. Hardee, J. M. Ainsworth)

Two years (1990-91) of sampling data for aphids on cotton showed that numbers of aphids collected per method of sampling vary as season progresses. A manuscript in preparation will detail which of four methods of sampling is recommended for use at different stages of plant growth. (D. D. Hardee, J. M. Ainsworth)

The Stoneville Research Quarantine Facility (SRQF) received twelve shipments of exotic insect material in 1991. Two of the shipments were received in support of the Helicoverpa zea sterile hybrid project. Helicoverpa spp. were received from the USSR and Indonesia. All Helicoverpa shipments were used for the crossing trials with H. zea. Three shipments of sweetpotato whitefly, Bemisia tabaci, parasitoids were received. The shipments included Encarsia formosa from Greece, Eretmocerus spp. from Spain, and an Encarsia sp. from Israel. Plans are to clear these parasitoids and then release to cooperators. Four shipments of Trichogramma sp. from USSR were received with two currently being maintained in the SRQF. One shipment of Plutella xylostella was received from Korea in support of research on the diamond back moth. Two shipments of the Helicoverpa spp. parasitoids, Bracon hebetor, were received from Barbados and the USSR. Five shipments have been released from SRQF. Monthly quarantine meetings were held and were attended by regulatory personnel at the State and Federal level. An annual report of all SRQF activities for 1990 were compiled and distributed. (W. W. Harrison, F. M. Williams)

Pterocormus promissorius (Erich) studies were completed, and results are currently being summarized. (W. W. Harrison)

The sweetpotato whitefly, Bemisia tabaci, project was expanded during 1991. Three shipments of exotic natural enemies were received from Greece and Spain, which included Encarsia formosa and Eretmocerus spp., respectively. These species have either been identified or in the process of being identified. Two shipments of E. formosa have been released to researchers in Florida. Plans are currently underway to release shipments to California, Texas, and Arizona. (W. W. Harrison, D. D. Hardee)

Insect production for USDA-ARS research in 1991 required maintenance of nine insect species: Heliothis virescens sterile hybrid, Helicoverpa zea, Heliothis virescens, Anticarsia gemmatalis, Pseudoplusia includens, Galleria mellonella, Spodoptera exigua, Cardiochiles nigriceps, and Microplitis croceipes. Research by USDA-ARS scientists at Stoneville and laboratories in Beltsville, MD; Colombia, MO; College Station, TX; Mississippi State, MS; Weslaco, TX; Fargo, ND; and Ithaca, NY required production of: 642,000 H. virescens pupae; 338,000 H. zea pupae; 234,000 S. exigua pupae; 166,000 A. gemmatalis pupae; 275,000 P. includens pupae; 180,000 H. virescens sterile BC puae; 129,371 M. croceipes cocoons; 23,977 C. nigriceps cocoons; 26,000 G. mellonella larvae; 67,152,000 H. virescens eggs; 37,560,000 H. zea eggs; 19,755,000 S. exigua eggs; 10,130,000 A. gemmatalis eggs; 24,160,000 P. includens eggs; and 9,600,000 H. virescens sterile BC eggs. Additional research support included mixing, dispensing, and filling of 159,517 30 ml plastic cups and 1,566 3.8 liter multicellular trays with artificial insect diet. Total diet mixed and dispensed in 1990 was 17,043 liters. Also, assistance was provided to several scientists in maintaining insecticide resistant colonies of H. virescens and P. includens. (G. G. Hartley)

Participation in the 1991 Cotton Foundation TBW-BW Distribution Program was consistent with previous years with sixty-five researchers located in 23 states and England requesting insects. Participants were supplied with 1,217,000 eggs and 73,425 pupae of the tobacco budworm and bollworm. Income of $39,907.62 was derived after 20% administrative costs were deducted. These funds were used to purchase insect rearing supplies and pay temporary labor. Participation in this program is expected to remain at the same level in 1992. (G. G. Hartley)

Participation in the American Soybean Association's Insect Distribution Program continues to grow with 50 researchers located in 19 states and England requesting insects. Participants were supplied with 1,109,000 egggs and 16,000 pupae of the bollworm, soybean looper, velvetbean caterpillar, and beet armyworm. Income of $23,457.42 was realized after 10% administrative costs were deducted. A moderate increase in participation is expected for this program in 1992. (G. G. Hartley)

The insect rearing area in Building #9 (trailer complex) required renovation of the building and equipment to prepare for production of H. virescens sterile hybrid backcross. The west side of this complex is complete and was put into operation December 2, 1991. The east side should be completed in early February 1992 and will be put into service March 2, 1991. (G. G. Hartley)

Season-long experiments to study the preference of Heliothinae spp. for either cultivated cotton or velvetleaf (Abutilon theophrasti) in relation to crop phenology and weather clearly indicated that velvetleaf is a plant host of major importance for perpetual support of these species. This season-long study revealed that velvetleaf was an attractive host used by female budworm and bollworm moths for oviposition. In the prescence of blooming cultivated cotton plants, velvetleaf was more attractive to female moths and oviposition was significantly higher on velvetleaf. (D. E. Hendricks)

A nation-wide cooperative project to collect Heliothinae moths for determining the origin of dispersing moths by genetic-DNA fingerprinting was initiated. This involves 28 cooperative entomologists collecting moths at standardized "time windows" throughout the year, and chemical analyses are being done by Karl Narang, ARS Fargo, ND. This study might also identify moths that migrate or otherwise disperse from one crop area to another on a meso-scale. In cooperation with James Mallet and Amy Korman, Mississippi State University, similar studies, using fatty acid analyses, indicated that tobacco budworm populations separated by 85 km might be uniquely different. (D. E. Hendricks)

Methods of preparing and condensing chemical extracts from specific parts of cotton, velvetleaf and other herbaceous plants were developed. These extracts will be bioassayed as separate mixtures or in conjunction with sex pheromone compounds to test for attractancy or repellency. Formulations of chemicals identified from attractive parts of host plants may be incorporated with toxins as a foundation for use as an attracticidal bait for tobacco budworms, bollworms, or other pests of cotton. (D. E. Hendricks)

Surveys of Heliothinae spp. moth populations using replicated installations of pheromone traps baited with appropriate pheromone baits showed that 30-in. diam. inverted-cone pheromone traps caught about 3 times more bollworms and 2.6 times more budworm moths than 24-in. diam. traps of the same design. There were indications that the increased effectiveness of 30-in. diam. traps was somewhat dependent upon density of the field populations. Correlation of weather conditions with population profiles during the growing season indicated that severe winter or springtime freezing or flooding may delay or prevent the buildup of larval populations during the cotton-growing season to below economically important levels. (D. E. Hendricks)

Field experiments conducted in Coahoma Co., Mississippi indicated that both (H. virescens x H. subflexa) BC moths and native H. virescens preferred a 3-component lure (including Z-11-hexadecen-1-ol) when used as bait in traps, vs. a 2-component bait. BC moths used in the evaluation were tagged and released in Coahoma Co., Mississippi during the springtime months. The 3-component bait is now the "standard bait" for tobacco budworm moths marketed by industrial sources. (D. E. Hendricks)

Studies were conducted after the 1991 springtime floods in the Mississippi Delta region to compare population profiles with those of 5 previous years. Survival potentials of flooded or frozen pupae were indicated by peaks in subsequent population profiles derived from moth trapping and by weekly surveys of eggs and larvae. Results indicated that survival potential was reduced by flooding. This information was correlated with pupal survival experiments conducted in the laboratory which indicated that mortality in non-diapausing bollworm or budworm pupae can be correlated directly with the number of days that pupae remain in soil saturated with water. These conditions may prevail in overwintering sites in watersheds of major drainage systems (rivers) or when rainfall produces flooding and saturates the soil in fields of cultivated host plants where the insects have overwintered or diapaused as pupae. Drowning may occur in the fields in the early spring just before the adults emerge if flooding persists. (D. E. Hendricks)

Cooperative lab and field studies were conducted to determine the effectiveness of several nuclear polyhedrosis viruses in controlling lepidopteran pests of soybeans, primarily the soybean looper. Results indicated a significant reduction in emergence of loopers after field infection. (L. Lambert, M. R. Bell)

Evaluation of twelve insect resistant soybean genotypes with different maturity dates was made for a second year to determine if resistance levels change during plant maturation. The studies were conducted in a large field cage utilizing laboratory reared insects. It was found that all genotypes had essentially the same level of resistance prior to fruiting. After the onset of fruiting the later maturing genotypes exhibited a higher level of resistance than earlier maturing genotypes. Additional studies will be required to determine if resistance levels decrease during the fruiting phase or if later maturing genotypes develop higher levels of resistance. (L. Lambert, E. Hartwig)

Studies were conducted to determine the virulence of a recently identified insect virus against four foliar feeding insect species which damage soybean. The virus was found to be highly active against tobacco budworm, bollworm, and soybean looper, but the activity level was very low against velvetbean caterpillar. In a field cage study it was found that application of the virus to plants with five-day-old soybean looper larvae resulted in a high level of larval infection. Due to the slow rate at which the virus eliminated the larvae, damage levels to plants were not reduced. However, a second generation of larvae never developed where the virus was applied. (L. Lambert, M. R. Bell, W. L. Solomon)

Field studies were conducted for the second year to determine the influence of drought stress on the suitability of insect-susceptible and insect-resistant soybean as a host for soybean looper. Soybean looper adults were introduced in small field cages which had been placed over irrigated and nonirrigated plants. More eggs were deposited on nonirrigated plants than on irrigated plants. However, after five days fewer larvae were found on nonirrigated plants than on irrigated plants. Additionally, defoliation levels after ten days was significantly lower on nonirrigated plants than on irrigated plants. Therefore, insect control measures may be reduced or not required on drought stressed plants since insect populations are lower and will develop more slowly. (L. Lambert, L. G. Heatherly)

In field cage evaluations of 600 accessions from the USDA-ARS soybean germplasm collection three genotypes were identified with high levels of resistance to foliar feeding by soybean looper. Evlauations with velvetbean caterpiller did not identify genotypes resistant to this species. These accessions will be further evaluated and used in a breeding effort to develop soybean cultivars with high levels of resistance to insects. (L. Lambert, T. C. Kilen)

Research on the tobacco budworm sterile backcross has continued with maintenance of two advanced backcross colonies, currently in the 200th and 64th generations. The sterile male trait has persisted in these colonies. Efforts to establish a laboratory colony from Heliothis subflexa larvae collected in 1990 were unsuccessful. H. subflexa larvae were collected again in 1991 to establish a laboratory colony, which if established, will be used for investigations with Heliothis parasites. (M. L. Laster)

The sterile tobacco budworm backcross was released in an 8-mile square area at Friars Point, Mississippi, from April 2 until May 24. Moths emerged from 17,000 pupae per day, marked internally with red dye and placed in 17 release stations spaced two miles apart. Rearing trays containing the pupae were brought from the field after 10 days and an average percent emergence was determined. Wire cone pheromone traps were used to monitor moth emergence and distribution. Moth emergence was poor (40.3%) until May 20, when the minimum temperature stabilized above 60°F. The average moth emergence after May 20 was 95.1%. The average emergence for the entire release period was 63.2%. Trap captures indicated that released moths were distributed over the entire release area with an overall wild:release ratio of 1.0:1.4. Paired matings with males captured in traps during July showed a tobacco budworm:BC ratio of 1.4:1.0. Poor moth emergence during cool periods and collapse of some cardboard release boxes during rainy periods were problems identified during these release studies that could adversely affect a release program. (M. L. Laster)

A search for hybrid sterility in Helicoverpa zea was continued with importations of foreign Helicoverpa species for crossing studies with H. zea. Attempts to establish laboratory colonies of H. fletcheri from Mali and H. assulta from Zimbabwe were unsuccessful. Helicoverpa armigera from the USSR near Tashkent was received in the Stoneville Research Quarantine Facility and crossing studies have begun. (M. L. Laster, D. D. Hardee)

There were no differences in the amount of residual insecticides found on cotton leaves when Capture was applied at the .06 lb/acre rate in 1, 3, and 6 gal of water. (J. E. Mulrooney, A. R. Womac, W. P. Scott)

Initial studies on spread of oils on leaves of different cotton varieties indicated that various oils used as carriers for insecticides may act differently on smooth and hairy leaf cottons. (J. E. Mulrooney, W. P. Scott, A. R. Womac)

High and low densities of adult Microplitis croceipes were released in geranium patches that bordered cotton fields. The purpose was to determine if populations would buildup and remain in the area, thus move into cotton when it squared. Season-long surveys were made by placing II-III instars of Heliothis virescens in marked locations in cotton, with recoveries made 24-48 hr later. Larvae were held in the laboratory to allow the development of parasitoids. Results showed that Microplitis populations again were practically non-existent in cotton. In fact, the releases made early-season had no effect on Heliothis populations, most likely due to pesticide applications in the area. (J. E. Powell, J. R. Roberson)

Frass was collected from larvae that fed on field-collected geranium. Bioassays were conducted by J. Tumlinson to determine activity, but further studies were not conducted as part of semiochemical project. (J. E. Powell)

Crystals extracted from leafy spurge were placed in solution, then used to evaluate anti-feeding response of Heliothis virescens. This material is known to inhibit feeding in some insects. In this study, the response was variable even within a large dosage range. (J. E. Powell, N. R. Spencer)

The SIML spray tower was used to evaluate the effects of certain insecticides on developing Microplitis demolitor within the host, Heliothis virescens. Larvin, Karate, Vydate, Curacron, Capture, and Bolstar were the compounds tested. Applications made to developing Microplitis croceipes included Bolstar, Curacron, Larvin, Karate, Vydate, Capture and Guthion, while applications made to developing Cardiochiles nigriceps included Vydate and Capture. As parasitoids developed, they were affected less by the insecticides. (J. E. Powell, M. L. Laster, D. D. Hardee)

Normal DPL-90 and its nectariless counterpart were grown in the greenhouse to measure the existence of any negative effects on Microplitis croceipes. Heliothis virescens larvae were placed on plants, then adult wasps were released. Adult wasps attacked host larvae on both plant types, and parasitoid development was complete for both plant types. (J. E. Powell, D. D. Hardee)

The Insect Rearing Research Unit (IRRU) maintained colonies of Anthonomus grandis grandis, Heliothis virescens, Helicoverpa zea, and Microplitis croceipes for service support and mass-rearing research assignments. Service accomplishments were as follows. 1) Produced and shipped approximately 2.5 million boll weevils to Cotton Foundation recipients; 2) Processed diets and test specimens for boll weevil and

Heliothis virescens studies were provided to local ARS and MAFES scientists for material reimbursement costs; 3) Produced 1.3 million Heliothis virescens backcross for IPM adult dispersal studies, and 1.0 million Helicoverpa zea larvae for NPV virus production. (J. L. Roberson, D. K. Harsh, O. L. Malone)

IRRU research accomplishments: Anthonomus grandis grandis - Designed, constructed, and tested a mechanized process to form 1.0 x 0.7 cm cells in parafilm sheeting and mechanically load third instar larvae for parasitization. The process replaces hand operations that previously negated production of parasites as an applied field control concept. Research studies included development of critical collection, loading, holding, and shipping procedures. (D. K. Harsh, J. L. Roberson). Heliothis virescens/Helicoverpa zea - Compared liquid vs dry mix egg distribution mediums, evaluated manipulation of egg hatch/larval growth rates in variable temperature regimes, and evaluated use of multiple cell tray heavily infested with Heliothis virescens larvae for Microplitis croceipes parasite production. (J. L. Roberson, O. L. Malone, E. M. Griffin). Microplitis croceipes - Designed a combination parasite rearing/field release container that utilizes Heliothis virescens backcross larvae as hosts for the parasite. The proposed rearing/release process will reduce operational process, production costs, and permit utilization of all insects in the containers. Supported research studies with P. P. Sikorowski, MAFES, to identify nonoccluded baculovirus (NOV) in all stages of Microplitis croceipes to be used for development and maintenance of a virus free production colony. (J. L. Roberson, O. L. Malone, D. K. Harsh)

In 1991, different rates of aldicarb applied as in-furrow and sidedress treatments were evaluated for the 3rd year for aphid and spider mite suppression. Aphid populations were extremely low; therefore, there were no differences between treatments. No spider mites were observed in cotton during the season. Higher yields were obtained in all aldicarb treatments when compared to the foliar treatments. In-furrow plus sidedress treatments of aldicarb did not increase yields over that obtained with in-furrow only treatments. (W. P. Scott)

Research was initiated in 1991 to determine similarities or differences of early-season insect populations, yield, and earliness of narrow row (30") and normal row (38-40") plantings of cotton. Due to heavy rains in April and early May, there was a three-week difference in planting dates of the two test fields. Treatments in both fields included in-furrow applications of Disyston, granular Orthene, Temik and foliar treatments. Due to differences of planting dates, direct

comparisons of the two fields could not be made. Thrips populations were extremely low in 1991. Several insecticide applications were made early to control large plant bug and overwintering boll weevil populations. In both fields, Temik treated cotton had higher yields than other treatments. (W. P. Scott)

Comparative GC and GC-MS analysis of the foliar cuticular chemistry of pecan and the other hickory and walnut species were performed. Although the data have not been thoroughly analyzed, there are differences in the foliar cuticular chemical composition among these tree species. (R. F. Severson, M. T. Smith)

Investigations of host plant resistance, host plant specificity and host plant selection of the blackmargined aphid, Monellia caryella (Fitch), on pecan were continued. Closely related tree species of pecan, all of which are North American species of the Juglandaceae family of nut trees, were evaluated in regard to their suitability as a host for M. caryella. Nymphal survival and developmental rate, and adult survival and reproductive rate were studied on all thirteen hickory (Carya) species, one hybrid species (hican) and two walnut (Juglans) species. Pecan, hican, water hickory, scrub hickory, shellbark hickory, and sand hickory were shown to be acceptable host plants of nymph M. caryella to varying degrees. Pecan, hican, water hickory, scrub hickory and shellbark hickory were shown to be acceptable host plants of adult M. caryella to varying degrees. Monellia caryella failed to survive, develop or reproduce on any of the other Carya species and the two Juglans species. Behavioral studies of host plant preference showed M. caryella to prefer pecan, water hickory and hican over scrub, shellbark and sand hickory species. (M. T. Smith, B. W. Wood)

Investigations of the mechanism(s) of host selection (host recognition and host suitability) utilized by M. caryella were undertaken. Electronic monitoring of M. caryella feeding behavior on pecan and a select group of the other hickory species was performed. Although not as yet completed, analysis of the data should determine the specific location of the plant cue(s) on and/or within the foliar tissue which govern host acceptance or rejection behavior of M. caryella. (M. T. Smith, T. Perring, UCR, B. W. Wood, W. L. Tedders)

Behavioral bioassays were initiated in order to investigate what role, if any, specific foliar surface cuticular chemistry of pecan might play in the host recognition behavior of M. caryella. Bioassay techniques were developed and these studies are in progress. (M. T. Smith, R. F. Severson)

Investigations of host plant resistance among existing named pecan cultivars were initiated on a limited number of cultivars. Aphid populations were sampled weekly from bud break until leaf senescence. Analysis is pending. (M. T. Smith)

Aphis gossypii Glover density within the canopy of a cotton plant was measured at: (1) the 4th fully expanded leaf from the terminal, (2) the 1st main stem leaf one-third distance down from the terminal, and (3) the 1st main stem green leaf above the 1st fruiting branch from the ground. Aphid density was found to vary significantly within the canopy of a cotton plant. Furthermore, varying aphid density within the plant canopy changed with the phenological stage of cotton plant development. Therefore, it appears that any season-long sampling scheme utilized for A. gossypii, where the experimental unit is less than the entire plant, must consider within plant canopy variation (i.e. leaf location) and phenological developmental stage of the plant. (M. T. Smith, D. D. Hardee, M. Ainsworth)

Six fungicides applied at planting were evaluated to determine their effects upon the incidence and prevalence of the entomopathogenic fungus Neozygites fresenii, a natural controlling agent of A. gossypii. Although not statistically significant, it appears that Terrachlor Super-X (5 & 10 lb) and Vitavax 4G may have some effect on the incidence of the N. fresenii among the cotton aphid. Sufficient sample size may have prevented the detection of statistical significance. Furthermore, given the significant variation in aphid density within the plant canopy and across the phenological stages of plant development, detection of significant adverse effects of the fungicides on N. fresenii may have been masked. Therefore, re-evaluation of these compounds is warranted before any conclusions may be drawn. (M. T. Smith, D. D. Hardee, M. Ainsworth)

Investigation of the factors (biotic and abiotic) governing the seasonal dynamics of A. gossypii were initiated. Among the biotic factors considered, early season A. gossypii populations appear to be significantly regulated by insect parasitism, while late season populations are more significantly regulated by epizootics of N. fresenii. Variation in parasitoid searching behavior within the plant canopy associated with aphid distribution, coupled with insecticidal pressures, may account in large part for the significant reduction in late season aphid parasitism by insect parasitoids. Among the abiotic factors considered, it appears that leaf wetness may have a significant effect upon the simultaneous late season increase in N. fresenii incidence and A. gossypii population density decrease. While it appears that the cotton plant

itself possesses some regulatory factors as well, the present study was not designed to partition the environmental and host plant effects on aphid population dynamics. (M. T. Smith, D. D. Hardee, M. Ainsworth)

Over 2300 tarnished plant bug nymphs were collected from several wild host plants in May-August in an undisturbed area of Washington County and reared to determine if they were parasitized by Leiophron schusteri Loan or Peristenus nigricarpus (Szepligeti). Both species of braconid wasps (obtained from Kenya) had been reared using Lygus nymphs as hosts in the Stoneville Research Quarantine Facility, and were released in the collection area in May 1987. No parasites were obtained from the nymphs (or in collections made in the previous 3 years) and the attempt to establish the parasites may have failed. (G. L. Snodgrass)

A survey of the species of egg parasites of the tarnished plant bug present in the Mississippi Delta was continued in 1991. Wild host plant material containing plant bug eggs was collected and held for parasite emergence in the laboratory. Parasites that emerged were placed with plant bug eggs laid in green beans to see if the parasites utilized the eggs as hosts. Collections were made mostly in Washington County from April through October with samples taken mainly from 3 species of Erigeron. During the 2 years of the study, samples from 20 different plant species were used in the study. The only egg parasite found and confirmed to attack tarnished plant bug eggs was the mymarid Anaphes iole (Girault). It was found to parasitize plant bug eggs in samples taken from 9 different plant species from May through September. A. iole was rarely found in samples from host plants growing near cotton fields. (G. L. Snodgrass)

An alfalfa field located in the edge of the Delta near Holcomb, Mississippi, was planted in October. This field will be a release site for Peristenus digoneutis Loan this spring. P. digoneutis is a braconid wasp that parasitizes nymphs of the tarnished plant bug. (G. L. Snodgrass)

Work on the development of a bioassay for testing various chemicals for activity against eggs of the tarnished plant bug was mostly completed. Aldicarb was the test chemical used to develop the procedure. Eggs were found to be affected by concentrations of aldicarb in water as low as 1:100,000. However, at a concentration of 1 ppm which is closer to the concentration that might be found in plant tissue, aldicarb had no effect on egg hatch. (G. L. Snodgrass)

Two canola fields located in the northern Delta near Tunica were sampled during April and May with a sweep net for tarnished plant bugs. Reproductive populations of adults were found in both fields and at least 1 new generation of adults was produced in each field. Population levels averaged as high as 12 nymphs and adults per 10 sweeps. Adults produced in April and May would be available to move into cotton during May and June, or onto other wild hosts and produce a new generation that could move into cotton in June and July. (G. L. Snodgrass)

A study on the efficiency of the sweep net (38 cm diam.) in capturing adult tarnished plant bugs in cotton was begun in 1991. Preliminary results indicate that sampling efficiency is affected more by the location of the adult on the plant sampled, than by the size of the plant. (G. L. Snodgrass)

Regression equations developed for correcting counts taken to estimate tarnished plant bug nymphal populations in cotton with a sweep net or drop cloth were tested again in 1991. The test was conducted during the first 5 weeks of square production in a cotton field at Stoneville, Mississippi, that had a natural infestation of plant bugs. The sweep net again (as in 1990) did a poor job in sampling nymphs. Agreement between corrected numbers of nymphs (obtained by correcting counts taken with the sweep net) and numbers captured with an absolute sampling method was only 40.5%. The drop cloth did a better job of sampling the nymphs. Agreement between the number estimated by correcting the drop cloth counts and the number captured in the absolute samples was 83.2% (87.5% during the first 3 weeks of sampling). (G. L. Snodgrass)

Studies with Larvin indicated that the downward blast of air from the Hardi Sprayer was not advantageous in controlling insects that feed on the bottom side of leaves when compared to the conventional sprayer. The reverse is true on insects that feed in squares. In all cases, Larvin applied at the 10 gpo volume gave better control than the 5 gpo volume. (A. R. Womac, W. P. Scott, J. E. Mulrooney)

2. Extramural

Cooperators on a PL-480 project in India have set up a rearing program for parasitoids of Helicoverpa, and are improving their techniques. Field cage studies were delayed until next year due to lack of equipment. Parasitoid surveys in several host plants have been completed. (J. E. Powell)

B. Indicators of Progress

1. Publications (Published, In Press, Accepted)

Bell, M. R. 1991. Effectiveness of microbial control of Heliothis spp. developing on early season wild geraniums: Field and field cage tests. J. Econ. Entomol. 84: 851-854.

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Bell, M. R., and D. D. Hardee. 1991. Aerial application of an entomopathogenic virus as an area wide management program of early season bollworms and budworms. Proc. XII International Plant Protection Congress. August 11-16. Rio de Janeiro, Brazil. (Abstract)

Bell, M. R., Hardee, D. D., and Hayes, J. L. 1991. Application of baculovirus for area-wide management of tobacco budworms and cotton bollworms with emphasis on the public information strategy and implementation. Proc. Joint EPA, Canada Environment, and Maryland Biotechnological Institute symposium "Issues Associated with the Large-Scale Field Release of Insect Viruses", Rockville, MD Oct 9-10. (Abstract - In American Soc. for Microbiology News).

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Elzen, G. W. Cotton aphid control, 1990. Insecticide and Acaricide Tests. In Press.

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Gueldner, R. C., and M. T. Smith. 1991. Seasonal changes in components of leaf, rachis and nuts of pecan as determined by HPLC. Abstract #30, 31st Annual Meeting of the Phytochemical Society of North America, June 22-26, 1991, Ft. Collins, CO.

Hardee, D. D. 1991. Non-insecticidal approaches to pest management in cotton - are we making any progress? Proc. 37th Annual Miss. Insect Control Conf., (Abstract), p. 37.

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Laster, M. L. 1991. The use of pheromone traps in bollworm/tobacco budworm management in cotton. Proc. 37th Annual Miss. Insect Control Conf. (Abstract), pp. 28-30.

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2. In Manuscript

Bell, M. R., and J. L. Hayes. Management of cotton bollworm/tobacco budworm populations through area-wide application of nuclear polyhedrosis virus on early-season hosts: Application, virus deposition, and cage studies. (For J. Econ. Entomol.).

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Smith, M. T., D. D. Hardee and W. P. Scott. Effects of fungicides applied at planting on the incidence and prevalence of the entomopathogenic fungus Neozygites fresenii among Aphis gossypii in cotton. (In Preparation).

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Snodgrass G. L. Estimating absolute density of nymphs of Lygus lineolaris (Heteroptera: Miridae) in cotton using drop cloth and sweep net samples. (In Peer Review).

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3. Presentations

Bell, M. R. "Spray efficiency of aerial applicatin of a nuclear polyhedrosis virus in area-wide treatment of early season hosts of bollworms/budworms." Beltwide Cotton Prod. Conf., San Antonio, TX, January 1991.

Bell, M. R. "Development of microbials for use in insect pest management systems." Orlando, FL, February 1991.

Bell, M. R. "Issues associated with the large-scale field release of insect viruses." Rockville, MD, October 1991.

Bell, M. R. "Mass in vitro production of an entomopathogenic virus for large scale tests." 38th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1991. (Invitation)

Elzen, G. W. "Further evaluation of Heliothis resistance to insecticides." Beltwide Cotton Prod. Res. Conf., San Antonio, TX, January 1991.

Elzen, G. W. "Tobacco budworm resistance management status and recommendations." Rhone-Poulenc Ag Co., Mid South Cotton Seminar, Monroe, LA, January 1991. (Invitation)

Elzen, G. W. "Early season Heliothis control." Mississippi Agricultural Consultants Association, 18th Annual Meeting, Greenwood, MS, February 1991. (Invitation)

Elzen, G. W. "Characteristics of Heliothis resistance." Louisiana Agricultural Consultants Association, Pest Management Consultants Workshop, Alexandria, LA, February 1991. (Invitation)

Elzen, G. W. "Further evaluation of Heliothis resistance and management update." Ciba-Geigy Cotton Consultant Meeting, Orange Beach, AL, March 1991. (Invitation)

Elzen, G. W. "Discussion participant." Ciba-Geigy Cotton Extension Entomologist Forum, Perdido Beach, AL, March 1991. (Invitation)

Elzen, G. W. "Report on recent results of research on Heliothis resistance." Insecticide Resistance Action Committee, Baton Rouge, LA, May 1991. (Invitation)

Elzen, G. W. "Heliothis resistance." Humphreys County Growers Meeting, Belzoni, MS, May 1991. (Invitation)

Elzen, G. W. "Larvin insecticide resistance." Rhone-Poulenc Executives Tour, Stoneville, MS, July 1991. (Invitation)

Elzen, G. W. "Tobacco budworm: Recent results of resistance research." 38th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1991. (Invitation)

Elzen, G. W., B. R. Leonard, J. B. Graves, E. Burris, and S. Micinski. "Resistance to pyrethroid, carbamate, and organophosphate insecticides in recently collected field populations of tobacco budworm." National ESA Meeting, Reno, NV, December 1991.

Gueldner, R. C., and M. T. Smith. "Polyphenolic constituent differences in pecan tissues determined by HPLC analysis." 201st National Meeting, American Chemical Society, Atlanta, GA, April 1991. (Presentation made by Gueldner)

Gueldner, R. C., and M. T. Smith. "Seasonal changes in components of leaf, rachis and nuts of pecan as determined by HPLC." Abstract # 30, 31st Annual Meeting of the Phytochemical Society of North America, Ft. Collins, CO, June 1991. (Presentation made by Gueldner)

Hardee, D. D. "Resistant aphid update - distribution severity, chemical control." Rhone-Poulenc Ag Co. Mid-South Cotton Seminar, Monroe, LA, January 1991. (Invitation)

Hardee, D. D. "Summary of ARS research at Stoneville." Rhone-Poulenc Tour, Delta Research and Extension Center, Stoneville, MS, August 1991. (Invitation)

Hardee, D. D. "Pilot tests in biological control for 1992." USDA, ARS, Heliothis/Helicoverpa Workshop, San Antonio, TX, September 1991. (Invitation)

Hardee, D. D. "Role of in-furrow insecticides at planting on development of resistance in the cotton aphid. 38th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1991. (Invitation)

Hardee, D. D. "Influence of in-furrow insecticides on development of resistance of cotton aphids." National ESA Meeting, Reno, NV, December 1991.

Harrison, W. W., and D. D. Hardee. "Quarantine and research efforts on biological control of Bemisia tabaci." National ESA Meeting, Reno, NV, December 1991.

Hendricks, D. E. "Twenty years of developing insect detection methods and equipment." Department of Entomology, Mississippi State University, Mississippi State, MS, January 1991.

Hendricks, D. E. "Effects of soil flooding on survival and subsequent development of bollworm and tobacco budworm populations." 38th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1991.

Hendricks, D. E. "Preference of tobacco budworms and bollworms for velvetleaf vs. cotton in the Mississippi River Delta." National ESA Meeting, Reno, NV, December 1991.

Kaas, J. P., G. W. Elzen, and S. B. Ramaswamy. "Time budget and periodicity of behavior of Microplitis croceipes in field cages with Heliothis virescens on spring host plants." Insect Parasitoids, Tritrophic Interactions, 6th European Workshop, Pergia, Italy, April 1991, (Abstract) (Presentation made by Dr. Kaas)

Lambert, Lavone. "Status of Host Plant Resistance to Insects in Soybean." Soybean Looper Insecticide Resistance Workshop, Orange Beach, AL, March 1991. (Invitation)

Laster, M. L., E. A. Stadelbacher, and D. D. Hardee. "Distribution of Heliothis moths from a central release point." Beltwide Cotton Prod. Res. Conf., San Antonio, TX, January 1991.

Laster, M. L. "Pilot test to control the tobacco budworm by releasing sterile backcross insects." 38th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1991. (Invitation)

Laster, M. L. "A search for Helicoverpa zea hybrid sterility in the Helicoverpa complex." National ESA Meeting, Reno, NV, December 1991.

Leonard, B. R., E. Burris, J. B. Graves, and G. W. Elzen. "Tobacco budworm: Insecticide resistance and field control in the Macon Ridge Region of Louisiana, 1990." Beltwide Cotton Prod. Res. Conf., San Antonio, TX, January 1991.

Navasero, R. C., and G. W. Elzen. "Preference and performance of insect host and its parasitoid on host and nonhost plants." Southeastern Branch Meeting of ESA, Orange Beach, AL, March 1991.

Powell, J. E., M. L. Laster, and D. D. Hardee. "Managing parasitoids for control of Heliothis and Helicoverpa species." Beltwide Cotton Prod. Res. Conf., San Antonio, TX, January 1991.

Scott, W. P., A. R. Womac, and J. E. Mulrooney. "The effects of various diluents and insecticide rates on mortality of susceptible and resistant Heliothis virescens larvae." Beltwide Cotton Prod. Res. Conf., San Antonio, TX, January 1991.

Scott, W. P. "The benefits of controlling early-season pests of cotton and the effects on yield." Rhone Poulenc Cotton Earliness Seminar, Greenwood, MS, March 1991. (Invitation)

Scott, W. P., F. T. Cooke, and D. Caillavet. "Economic values of yield increases associated with the use of Temik and Prep in cotton." National ESA Meeting, Reno, NV, December 1991.

Smith, M. T. "Pest control panel: Pecan insect research overview, with an emphasis on alternative management strategies." Mississippi/Louisiana Pecan Growers Association Meeting, Ocean Springs, MS, June 1991.

Smith, M. T., R. F. Severson, and B. W. Wood. "Blackmargined aphid (Monellia caryella) host plant specificity among the Juglandaceae of North America." National ESA Meeting, Reno, NV, December 1991.

Snodgrass, G. L. "Efficiency of the drop cloth and sweep net in capturing nymphs of the tarnished plant bug in cotton." Southeastern Branch Meeting of ESA, Orange Beach, AL, March 1991.

Snodgrass, G. L. "Sampling problems with the tarnished plant bug in cotton." 38th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1991. (Invitation)

Snodgrass, G. L. "Canola production in the Mississippi Delta: Potential for increasing tarnished plant bug problems in cotton." 38th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1991. (Invitation)

Snodgrass, G. L. "Estimating actual population levels of nymphs of the tarnished plant bug in cotton with a drop cloth." National ESA Meeting, Reno, NV, December 1991.

Ward, K. E., J. L. Hayes, D. D. Hardee, and R. C. Navasero. "A comparison of oviposition preferences among populations of Helicoverpa zea originating from Texas, Mississippi, and North Carolina." National ESA Meeting, Reno, NV, December 1991.

4. Other Reports

Hardee, D. D., J. E. Powell, J. R. Coppedge, and R. M. Faust. National Action Plan for Heliothis/Helicoverpa. To be released to ARS Information Staff, 1992.

IV. Planned Research for Calendar Year 1992

A. Narrative

1. In-House

Since the second year of the area-wide NPV pilot test was not conducted due to severe weather, the planned test will be repeated in 1992, except on a somewhat reduced scale. The objective will be to determine the effectiveness of Baculovirus heliothis in reducing the emergence of tobacco budworm and cotton bollworm moths from early season hosts. The insect virus will be applied aerially to all weeds within a 6 X 6 mile test area, and the effect on the first seasonal generation of Heliothis will be evaluated. Within this study, the coverage and persistence of the virus will be examined, and the effect on adult emergence will be determined through cage studies within the test area, as well as pheromone trapping inside and outside the test area. Cooperative studies will be done with other scientists to properly evaluate this control method as an area-wide management tool for Heliothis management in the Mississippi Delta. Changes will be made in the program compared to the Spring 1990 test in order to improve application coverage. (M. R. Bell)

Laboratory bioassays of possible new or more active insect pathogens against major row crop pests will continue. (M. R. Bell)

A new baculovirus having a broad host range will be studied through laboratory bioassays against tobacco budworms and cotton bollworms. This study will determine the effect of low rates of the virus on all stages of these hosts. (M. R. Bell)

More detailed bioassays will be conducted to determine the inheritance of insecticide resistance in the tobacco budworm. Dose-mortality regressions will be used in these studies on two or more resistant strains. (G. W. Elzen)

Various synergists (butifos, piperonyl butoxide, sesamex) in combination with insecticides and B.t.'s will be tested on resistant tobacco budworms using topical and spray table bioassays. Promising mixtures will be tested in replicated field trials in cotton. (G. W. Elzen)

Levels of resistance to the three major classes of insecticides and B.t. in tobacco budworm strains collected from Louisiana and Mississippi (possibly other states) will be determined using topical, adult, neonate, and spray table bioassays. (G. W. Elzen, LSU, MSU)

The effect of alternation of classes of insecticides on development of resistance will be determined by sequential treatment of a multiple resistant strain of tobacco budworm. Resistance levels will be verified by use of the spray table bioassay and then the culture will be divided into four sub-strains. Each sub-strain will be treated with an insecticide in generation 1 (G1), survivors will be mated and the resulting G2 will be treated with a different insecticide. Survivors from G2 will be mated to produce G3 in which resistance levels will be determined. Throughout, the method of creating insecticide pressure and for determining levels of resistance will be the spray table bioassay. Because of the size of the experiment, alternation sequences will be limited to: 1) pyrethroid, pyrethroid; 2) carbamate, pyrethroid; 3) pyrethroid, carbamate; and 4) carbamate, carbamate. (G. W. Elzen)

A 9 X 9 mile square area in the Mississippi Delta will be the site of large-scale evaluations of the early-season effects on bollworm/budworm populations of aerial application of NPV, release of sterile hybrid budworms and Microplitis croceipes, and nectariless cotton. Each of these factors will be evaluated alone and in combination in an effort to reduce bollworm/budworm populations which migrate to cotton from early-season alternate hosts. (D. D. Hardee, M. R. Bell, L. Lambert, M. L. Laster, W. R. Meredith)

The Stoneville Research Quarantine Facility (SRQF) will continue to receive in-coming shipments from ARS personnel of biological control agents for the sweetpotato whitefly, Bemisia tabaci. Preliminary studies with these agents will be conducted in the SRQF which will then ship specimens to designated personnel after necessary clearance procedures are done. (D. D. Hardee, F. M. Williams, M. T. Smith, W. W. Harrison)

Systemic insecticide and sampling studies will be expanded from those conducted in 1990-91 in an attempt to confirm previous results and provide additional answers. Additional evaluations will be made of various alarm pheromones for cotton aphid as they become available. (D. D. Hardee, A. A. Weathersbee)

Plans are to continue to receive and evaluate exotic natural enemies in the Stoneville Research Quarantine Facility (SRQF). Natural enemies will be reared through at least one generation, identified and released to cooperators or held for quarantine study in the SRQF. Importations will be documented and voucher specimens maintained. An annul report of quarantine activity will be generated and distributed. (W. W. Harrison)

We will continue to receive and document exotic Heliothis in support of the bollworm sterile hybrid project. Protocol will be maintained and safe handling of pest species in the Maximum Security Area of the quarantine laboratory will be ascertained. Monthly meetings will be conducted and reports compiled and disseminated to quarantine and regulatory officials on the state and national level. Voucher specimens will be preserved and representative numbers will continue to be shipped to the state and national museums. (W. W. Harrison)

Work will be continued with the committee on Kudzu Management: Limiting the Spread and Reclaiming Lands. Plans are to hire a person to manage committee activities and reports and continue efforts for Regional Project Status. (W. W. Harrison)

SRQF will serve as the official quarantine facility for receipt of exotic natural enemies of the sweetpotato whitefly, Bemisia tabaci. Exotics will be identified at the ARS Systematics Entomology Laboratory and reared in the SRQF. When sufficient numbers are obtained the natural enemies will be released to interested cooperators. (W. W. Harrison, F. M. Williams)

The Stoneville insect rearing research support group will maintain nine insect species in 1992. These are tobacco budworm, tobacco budworm sterile hybrid BC, bollworm, soybean looper, beet armyworm, velvetbean caterpillar, greater wax moth, Cardiochiles nigriceps, and Microplitis croceipes. Also, assistance in maintaining insecticide resistant strains of

several species will be provided to individual scientists. Artificial diet will be supplied in 30 ml plastic cups and 3.8 liter multicellular trays. Efforts will continue to produce high quality diets and insects at economical prices. The research of approximately 150 scientists within USDA-ARS, priviate industry, and state universities will be supported by the work of this unit. (G. G. Hartley)

The insect distribution programs with the Cotton Foundation and the American Soybean Association will continue in 1992. The Cotton Foundation program is expected to remain consistent with the previous year while moderate growth is expected for the American Soybean Association Program. Funds provided by these programs will be used to offset rearing expenses of the Southern Insect Management Laboratory. Prices for insects provided will remain the same until September 30, 1992. At this time, both programs will be evaluated to determine if a price increase is needed to keep pace with rearing expenses. The egg and pupal/stage of the following species will be available: tobacco budworm, bollworm, beet armyworm, soybean looper, velvetbean caterpillar, and Microplitis croceipes (cocoon only). (G. G. Hartley)

The Stoneville insect rearing group began establishing reproductive colonies of the tobacco budworm sterile hybrid backcross on December 2, 1991, in preparation for a 1992 sterile backcross release of 80,000-100,000 moths per day over a six-eight week period. The Stoneville group will rear both the tobacco budworm and the sterile backcross and perform the necessary sexing required to provide 1,600 female BC pupae and 1,600 male TBW pupae per day to the Gast Rearing Laboratory at Mississippi State, MS. The Gast Lab will emerge the pupae, mate the adults, collect eggs, and implant the eggs in disposable trays of diet. The egg implanted trays will then be returned to Stoneville where they will be held for development and subsequent field release. (G. G. Hartley)

The preferences of Heliothis/Helicoverpa spp. for host plants will be studied to determine their dependency on wild plant hosts that serve as reservoirs for winter and early season populations. (D. E. Hendricks)

Techniques will be developed and methods optimized for sampling and detecting insect populations in field conditions, and monitoring their behavior and seasonal densities including meso- and micro-dispersal habits. (Species: tobacco budworm, bollworm, fall armyworm). (D. E. Hendricks)

A study will be made of survival mechanisms associated with bollworm and tobacco budworm pupation process and pupae mortality correlated with the soil environment in typical agronomic conditions. (Bollworm and tobacco budworms). (D. E. Hendricks)

A study of the origin of dispersing Heliothis/Helicoverpa spp. populations will be made by genetic characterization of DNA and isoenzyme loci found in unique populations throughout the southern U. S. (In cooperation with many State and ARS entomologists.) (D. E. Hendricks)

Formulations will be developed and bioactive materials bioassayed, including attractants, disruptants, or attracticides affecting mortality or the behavior of insect pests of cotton and other agronomic or wild host plants. (Species: tobacco budworm, bollworm). (D. E. Hendricks)

Studies will be continued to determine if the genetic removal of soybean plant pubescence enhances the resistance levels of soybean genotypes with foliar feeding resistance to all species of foliar feeding insects. (L. Lambert, T. C. Kilen)

Studies to determine the influence of soybean plant maturity on insect resistance will be expanded to determine if resistance levels decrease during the fruiting phase or if it increases to a higher level in late maturing genotypes. (L. Lambert, E. Hartwig)

Studies will be continued to determine if a practical method can be developed for using an insect virus to control soybean-damaging insects. (L. Lambert, M. R. Bell, W. L. Solomon)

Research will be continued to determine the impact of drought stresses of soybean on all foliar feeding insect species. (L. Lambert, L. G. Heatherly)

Evaluations of the USDA-ARS soybean germplasm collection will continue in an effort to identify resistance to velvetbean caterpillar. (L. Lambert, T. C. Kilen)

Heliothis subflexa larvae collected from the field are being used to establish a laboratory colony. These insects will be mated with H. virescens to obtain hybrid and backcross progeny. These progeny will be compared with the parents to determine the preference and development of the endoparasitoids, Microplitis croceipes, M. demolitor, and Cotesia kazak. Data obtained will be used to determine if the parasitoids might have a significant impact on released backcross insects for tobacco budworm suppression. (M. L. Laster)

A pilot test to suppress the tobacco budworm with sterile backcross releases will be conducted in the Stoneville area of Mississippi with releases during 1992 and 1993. The release area will be 10 miles square and releases will be made for a six-week period beginning about April 10. Moths emerging from 100,000 backcross pupae will be released each day from 25

release stations spaced two miles apart. Released insects will be grown on a diet in which red dye has been incorporated to serve as an internal marker for identifying released moths. Wire cone traps baited with female sex pheromone will be spaced at regular intervals throughout the release area to monitor emergence, distribution of released insects, and to determine released:wild ratios. Populations will be monitored during June and July by using pheromone trap catches, as well as egg and larval collections from cotton fields in the release area. Males collected during this period will be paired with virgin females to determine their fertility status and estimate fertile:sterile ratios. (M. L. Laster, D. D. Hardee)

The Helicoverpa zea sterile hybrid project will continue with crosses between the American H. zea and H. armigera from the Soviet Union. These crosses will be advanced to the fourth backcross generation and evaluated for male sterility. Other exotic species will be treated in a like manner as they become available. If sterility is detected in any of the crosses, it will be investigated for its possibilities as a control mechanism for H. zea. (M. L. Laster, D. D. Hardee)

The IRRU will continue maintenance colonies of Anthonomus grandis grandis, Heliothis virescens, Helicoverpa zea, and Microplitis croceipes for mass-rearing research and production service. Diet preparation, tray assembly materials, and colony insects will be provided upon request to local federal/state scientists and Cotton Foundation recipients for reimbursement of material/processing costs. An active technology transfer policy will be initiated with other insect rearing operations to incorporate mechanized production processes within their programs. (J. L. Roberson, D. K. Harsh, O. L. Malone)

Major mass-rearing research programs for the IRRU are identified as follows. 1) Evaluation of Heliothis virescens backcross larvae as host for Microplitis croceipes parasite production. 2) Evaluation of Microplitis croceipes cardboard rearing containers for field station release method. 3) Selection of virus-free Microplitis croceipes maintenance colony using methods established by P. P. Sikorowski, MAFES, Mississippi State, Mississippi, NOV studies. 4) Develop advanced mechanization processes for loading boll weevil larvae in parafilm sheeting for parasitization. 5) Construct tray assembly equipment for the larger Kutter tray thermoforming equipment. 6) Investigate feasibility of producing predator insects by adapting to host production in thermoformed rearing trays. (J. L. Roberson, D. K. Harsh, O. L. Malone)

The IRRU will provide approximately 4.2 million Heliothis virescens backcross insects for a 6-week period field release program. Pupae for the laying colony will be provided by the Stoneville, Mississippi laboratory. The IRRU will construct an oviposition room, oviposition cages, and an improved egg washing machine. (J. L. Roberson, D. K. Harsh)

The spray table and small field plot tests will be used to evaluated promising new chemistry on pests that occur in coton in the Mississippi Delta. (W. P. Scott)

Studies on narrow-row cotton will continue. In Mississippi during 1991, 25,000 to 30,000 acres were planted to 30" row cotton. The interest continues to grow. Very little is known on the behavior of insect pests that occur in cotton planted on a narrow row. In 1991, not only were the test fields planted 3 weeks apart, they were also under two separate management systems. These factors did not allow direct comparison. In 1992, test fields will be under the same management to allow more control and comparison of narrow row and normal row plantings. (W. P. Scott)

Studies on the management of early season pests of cotton and the effect on yield and maturity in both plantings will be conducted. Information gained will be available to MAFES Agricultural Economists to determine actual benefits that are derived from earliness and increased yields associated with narrow row cotton. (W. P. Scott, F. T. Cooke)

Studies will be made to determine if the tarnished plant bug prefers 30" to 40" plantings of cotton. Information gained on plant bug sampling will better enable us to estimate population numbers more accurately. (W. P. Scott, G. L. Snodgrass)

Investigations of host plant resistance, host plant specificity and host plant selection of the blackmargined aphid, Monellia caryella (Fitch) will be continued. Closely related tree species of pecan, all of which are North American species of the Juglandaceae family of nut trees, will be evaluated under natural field conditions in regard to their suitability as a host for M. caryella. Electronic monitoring of M. caryella feeding behavior on orchard-sized trees is planned. (M. T. Smith, B. W. Wood, W. L. Tedders)

Investigations to elucidate the mechanism(s) which govern the host specificity of M. caryella among the hickory and walnut species native to the United States will continue. Comparative analysis of the foliar cuticular chemistry of pecan and the other hickory and walnut species will continue and be expanded to include the intracellular and phloem tissues. (M. T. Smith, R. F. Severson, B. W. Wood, R. C. Gueldner)

Behavioral bioassays will be conducted to determine the role, if any, of specific foliar surface cuticular chemistry of pecan in the host recognition behavior of M. caryella. Furthermore, behavioral bioassays will be conducted to determine the role, if any, specific foliar internal chemistries (i.e. phloem and/or intracellular) of pecan might play in the host acceptance behavior of M. caryella and which govern the suitability of pecan as a host for M. caryella growth and reproduction. (M. T. Smith, R. F. Severson, R. C. Gueldner)

Investigations of host plant resistance will continue and expand within existing named pecan cultivars. (M. T. Smith, B. W. Wood, W. L. Tedders, R. F. Severson, R. C. Gueldner)

Investigations of the sexual cycle of M. caryella, will be initiated and include: (1) studies of the cues which control the induction of the sexual cycle, and (2) studies of the semiochemical cues which might function in M. caryella mating behavior. (M. T. Smith, W. L. Tedders, R. F. Severson, R. C. Gueldner)

Monellia caryella seasonal dynamics as it relates to the interactions among the pecan tree, the aphid herbivore and key environmental factors will be undertaken. In this context, field and colony aphids, field and greenhouse pecan foliage, and field and environmentally controlled chamber conditions will be compared in a complex matrix design in order to determine the factor(s) which govern the mid-season M. caryella population crash. (M. T. Smith, W. L. Tedders)

Behavioral studies of the adult green lacewing, as it relates to its feeding and ovipositional behavior, will be initiated. The objectives of these studies are to understand what factors govern lacewing movement in a pecan orchard:cover-crop system. (M. T. Smith, W. L. Tedders)

Insect:plant:parasitoid interactions of the sweetpotato whitefly, Bemesia tabaci Gennadius, will be investigated within the context of host plant resistance and biological control. More specifically, host finding and host selection processes of B. tabaci will be investigated in a comparative study of a wide range of its known host plant species. Natural enemy developmental biology, feeding behavior, oviposition and searching behavior on a wide variety of B. tabaci known host plant species will be investigated. (M. T. Smith, D. D. Hardee)

Cocoons of the braconid wasp Peristenus digoneutis Loan obtained from Bill Day at the Beneficial Insects Introduction Research Laboratory in Newark, Delaware will be released into an alfalfa field located near the edge of the Delta at Holcomb, Mississippi. The field will be sampled to make sure it has an

infestation of tarnished plant bugs and that nymphs are available for the wasps to parasitize when they emerge. If necessary, the field will be artifically infested with plant bugs. Samples from the field will be taken and the nymphs dissected or reared to determine if the parasite is becoming established. Samples of nymphs from weedy areas near the field will also be checked for parasites. (G. L. Snodgrass)

Canola fields located in different areas of the Delta will be sampled in April and May to better determine the extent that the tarnished plant bug utilizes these fields as an early-season host. If possible, fields located in the south Delta will be sampled. This will lead to a better understanding of the potential problem that production of canola in the Delta presents to cotton in terms of plant bug reproduction in canola followed by movement of the resulting adults from canola to cotton. (G. L. Snodgrass)

A survey to determine the species of egg parasites of the tarnished plant bug in the Mississippi Delta will be continued in 1991. (G. L. Snodgrass)

Work on the development of a bioassay for determining the susceptibility of tarnished plant bug eggs to various chemicals will be continued. Several different types of chemicals, especially those found in plants will be tested. (G. L. Snodgrass)

Experiments on sampling tarnished plant bug nymphs and adults in cotton will continue in 1992. Emphasis will be on sampling adults with a sweep net. (G. L. Snodgrass)

Controlled environmental studies will be initiated to determine optimum temperatures and relative humidities for development of the parasitic wasp, Lysiphlebus testaceipes, and the pathogenic fungus, Neozygates fresenii, in cotton aphids, Aphis gossypii Glover. The effects of host plant soil moisture and nutrient content will be evaluated as well. Greenhouse space will be required for cotton plant growth in different soil conditions and development of aphid infestations. Aphid infested plants then will be transferred to environmental chambers for developmental studies of the parasite and pathogen over a range of constant temperatures and humidities. These experiments will be initiated immediately, pending procurement of the fungus from Dr. D. C. Steinkraus, University of Arkansas, and the parasitic wasp from yet unknown sources. The alternative is to wait until natural populations of parasites and/or pathogens develop in the spring of 1992. (A. A. Weathersbee, D. D. Hardee)

Laboratory and greenhouse experiments will be initiated to study the potential effects of cotton herbicides and fungicides on development of the pathogenic fungus, N. fresenii, in cotton aphid. A search for compatible pesticides which will conserve this pathogen under field conditions is intended. (A. A. Weathersbee, D. D. Hardee)

Detailed biological control studies will be initiated with the fungus, Neozygates fresenii, and the braconid parasite, Lysiphlebus testaceipes, ultimately to determine their effectiveness in suppression of the cotton aphid. (A. A. Weathersbee, D. D. Hardee, M. T. Smith)

2. Extramural

A study with P. P. Sikorowski is partially funded by a Cooperative Agreement (ARS-MAFES) to determine color metric detection of nonoccluded baculovirus in all stages of Microplitis croceipes. The methods used are 1) enzyme linked immunosorbent assay (ELISA), and 2) production of monal clonal antibodies. The technology is to be used to 1) determine if Heliothis virescens is an asymptomatic carrier of NOV and 2) determine mechanism of NOV transmission. (P. P. Sikorowski, J. L. Roberson)